We claim:

1. A method for repairing an amplitude defect in a multilayer coating, comprising:

removing a defect that is causing said amplitude defect from said multilayer coating, wherein said detect is selected from the group consisting of a particle, a shallow pit and a scratch, wherein a damaged region of said multilayer coating will remain after removal of said defect; and

etching away said damaged region.

2. The method of claim 1, wherein the step of etching away said damaged region is carried out without disturbing the intact underlying layers of said multilayer coating.

3. The method of claim 1, wherein the step of removing a particle includes milling said particle out of said multilayer coating.

4. The method of claim 3, wherein the step of milling is carried out with a focused ion beam (FIB).

5. The method of claim 4, wherein said FIB is operated near normal incidence.

6. The method of claim 4, wherein said FIB has a diameter less than 100 nm.

7. The method of claim 4, wherein said FIB comprises a gas source.

8. The method of claim 7, wherein said gas source comprises a gas selected from the group consisting of He, Ne, Ar, Xe, F, Cl, I and Br.

9. The method of claim 4, wherein said FIB comprises a liquid metal source.

10. The method of claim 9, wherein said liquid metal source comprises a liquid metal selected from the group consisting of Ga, Si, In, Pb and Hg.

11. The method of claim 4, further comprising imaging said defect with said FIB.

12. The method of claim 1, further comprising imaging said defect during the step of removing and the step of etching.

13. The method of claim 12, wherein the step of imaging is carried out using a focused ion beam.

14. The method of claim 1, wherein the step of etching away said damaged region is carried out using an ion beam having a voltage of less than 5000 V.

15. The method of claim 14, wherein said ion beam has a diameter within the range from about 10 nm to about 1 mm.

16. The method of claim 14, wherein said ion beam is rotated with respect to said multilayer coating to improve the uniformity of the etching process.

17. The method of claim 1, wherein the step of etching away said damaged region is carried out at a temperature less than 200 °C.

18. The method of claim 1, wherein the step of etching away said damaged region produces a crater in the surface of said multilayer coating that has a diameter of greater than 10 μm and a depth of less than 150 nm.

19. The method of claim 1, wherein the step of etching away said damaged region is carried out using an ion beam at an angle of incidence that is less than 20 degrees from the surface of said multilayer coating.

20. The method of claim 19, wherein said ion beam is rotated with respect to said multilayer coating to improve the uniformity of the etching process.

21. The method of claim 4, further comprising removing atoms implanted by milling step to remove defect

22. The method of claim 1, wherein said particle is on the top of, or imbedded near the surface of, said multilayer coating, surrounded by a localized region of damaged multilayer coating.

23 ~~24.~~ The method of claim 1, further comprising minimizing the slope of the surface of said multilayer coating in the repaired region.

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25. The method of claim 1, further comprising depositing a Si layer subsequent to the step of removing a defect, wherein said Si layer iis about 1 to 4 nm thick, wherein said Si layer limits oxidation of the exposed multilayer coating.

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26. A method for repairing an amplitude defect in a multilayer coating, comprising physically removing the defect and leaving a wide, shallow crater that exposes the underlying intact layers to restore the local reflectivity of the coating.

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27. An apparatus for repairing an amplitude defect in a multilayer coating, comprising:

an ion beam source for producing an ion beam;

a mount for holding and positioning a substrate carrying a multilayer coating; and

ion beam optics for focusing said ion beam onto said multilayer coating for removing said defect and for etching away any damaged region that remains upon removal of said defect.

28. The apparatus of claim 27, wherein said ion beam optics are capable of focusing said ion beam onto said multilayer coating at a diameter of less than 100 nm.

29. The apparatus of claim 27, wherein said ion beam source comprises a gas source.

30. The apparatus of claim 29, wherein said gas source comprises a gas selected from the group consisting of He, Ne, Ar, Xe, F, Cl, I and Br.

31. The apparatus of claim 27, wherein said ion beam source comprises a liquid metal source.

32. The apparatus of claim 30, wherein said liquid metal source comprises a liquid metal selected from the group consisting of Ga, Si, In, Pb and Hg.

33. The apparatus of claim 27, further comprising means for imaging said defect with said ion source.

34. The apparatus of claim 27, further comprising means for rotating said ion beam with respect to said multilayer coating to improve the uniformity of the etching process.

35. The apparatus of claim 27, further comprising means for monitoring the temperature of said multilayer coating.

36. An apparatus for repairing an amplitude defect in a multilayer coating, comprising:

an Atomic Force Microscope (AFM) having the capability to produce a crater; and

a mount for holding and positioning a substrate in operable proximity to said AFM, wherein said substrate comprises a multilayer coating.

37. The method of claim 1, wherein the step of removing a defect is carried out with an Atomic Force Microscope (AFM) having the capability to produce a crater.